Accurate Measurements of the Sound Velocity in Pure Water under High Pressure

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Accurate measurements of the sound velocity in pure water are being conducted at the National Research Laboratory of Metrology (NRLM) as one of accurate determination of thermodynamic properties of liquid water. In a previous measurement in 1994, the pressure dependence of the sound velocity in pure water has been determined in a range 0-200 MPa and 303-323 K, where the sample water is filled between an ultrasonic buffer and an acoustic reflector, and the phase difference between the two ultrasonic echoes reflected from the buffer and the reflector is measured by using a coherent phase-detection technique. A single-crystal silicon spacer is used to determine the distance between the reflector and the buffer, where the pressure dependence of the thickness of the single-crystal silicon spacer is determined accurately from the second and third order elastic constants of silicon crystals. The sample water is compressed in a high pressure vessel, and the pressure is measured by using a calibrated dead weight gauge with an uncertainty of 1 x 10^{-4} . The relative changes of the sound velocities from the values under atmospheric pressure are measured along several isotherms. The sound velocity under high pressure is determined by referring to accurate sound velocity values for pure water under atmospheric pressure. The combined standard uncertainty of the sound velocity measurements under high pressure is estimated to be 5 x 10^{-5} .

In the present measurement, the temperature range is extended to 283-343 K. Details on the present sound velocity measurements and comparisons with the literature values are presented.